

## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (<http://bmjopen.bmj.com/site/about/resources/checklist.pdf>) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997–2017: A Longitudinal Analysis
<b>AUTHORS</b>	Valentin, Virginia; Najmabadi, Shahpar; Honda, Trenton

### VERSION 1 – REVIEW

<b>REVIEWER</b>	Edward Joseph Timmons Saint Francis University
<b>REVIEW RETURNED</b>	13-May-2021

<b>GENERAL COMMENTS</b>	<p>I believe that the authors are looking at a very important question. Understanding the interplay of expansion of SOP and wages is important research question. I have some comments to improve the manuscript.</p> <p>1.) More clearly interpreting the results-- the authors find little evidence that SOP expansion has increased PA wages. From a simple economics perspective, there are supply and demand forces. Demand for PAs has clearly increased. If supply has increased by a similar magnitude, perhaps owing to PAs having broader SOP, we would not expect higher wages for PAs from expanded SOP.</p> <p>It also isn't clear why there would then be a need for the government to intervene in some fashion to raise PA wages. This was my takeaway from the last sentence of the conclusion-- but perhaps the authors did not mean it this way. Why is a 220% increase in PA salary insufficient compensation?</p> <p>2.) I was surprised to not see a citation to a paper by John Perry: <a href="https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7287.2009.00162.x">https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7287.2009.00162.x</a> The paper found a similar conclusion for changes in PA SOP on PA income. I believe that a key factor to consider is independence-- this factor was not discussed in the manuscript. PAs generally have no pathway to independent practice-- unlike NPs. Although there is some movement in this regard in North Dakota <a href="https://www.aapa.org/news-central/2019/04/pas-across-america-celebrate-first-state-with-key-components-of-optimal-team-practice-following-the-legislative-victory-in-north-dakota/">https://www.aapa.org/news-central/2019/04/pas-across-america-celebrate-first-state-with-key-components-of-optimal-team-practice-following-the-legislative-victory-in-north-dakota/</a> and Utah <a href="https://www.sltrib.com/opinion/commentary/2021/02/24/conor-norris-edward/">https://www.sltrib.com/opinion/commentary/2021/02/24/conor-norris-edward/</a></p> <p>I think the authors could better frame the results in light of these important differences in SOP changes in PAs vs. NPs.</p> <p>Another paper by Morris Kleiner et al. finds similar NP wages</p>
-------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

	<p>increases associated with independence. Again-- a key facet missing from PA SOP expansion.  <a href="https://www.journals.uchicago.edu/doi/abs/10.1086/688093?journalCode=jle">https://www.journals.uchicago.edu/doi/abs/10.1086/688093?journalCode=jle</a></p> <p>3) I was surprised to not see an estimation that considered all aspects of PA SOP simultaneously. Perhaps none of the SOP changes independently are having an effect, but if PAs can co-sign AND have full prescriptive authority (or some other combination) that will make a difference. At the very least, using the index of SOP presented in Table 1 as a regressor would be an interesting addition. The mean and median SOP index is 2 for the first 3 years and then jumps to 3. I think it is important to perform an estimation (or estimations) that investigate(s) the effect of multiple SOP changes as well.</p>
--	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

<b>REVIEWER</b>	Benjamin J McMichael The University of Alabama System
<b>REVIEW RETURNED</b>	26-May-2021

<b>GENERAL COMMENTS</b>	<p>I appreciated the opportunity to review this paper. It addresses an important, timely, and chronically under-studied topic. Analyzing wage data (combined with PA characteristics and SOP law data), the authors examine wage growth for PAs and whether different SOP laws are associated with this growth. While the paper is generally well written and presents an interesting analysis, I have some comments that the authors may consider addressing. These comments are presented in no particular order.</p> <p>One</p> <p>The literature discussion seems to focus on studies in the medical and health services research literature. The paper's topic, however, lends itself to investigation by other researchers, particularly economists, and the authors may consider reading and citing some of this work. For example, Perry (2009) [<a href="https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7287.2009.00162.x">https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7287.2009.00162.x</a>] examines the impact of SOP laws on PA income. Stange (2014) [<a href="https://pubmed.ncbi.nlm.nih.gov/24240144/">https://pubmed.ncbi.nlm.nih.gov/24240144/</a>] and McMichael (2018) [<a href="https://onlinelibrary.wiley.com/doi/abs/10.1111/jels.12198">https://onlinelibrary.wiley.com/doi/abs/10.1111/jels.12198</a>] examine SOP laws and provider supply. Discussing these (and other) relevant papers outside of the medical and health policy literature would improve the paper.</p> <p>Two</p> <p>I believe the paper could be improved with a more robust discussion of the SOP laws and datasets under consideration. First, did the authors gather information on PA SOP laws themselves from the AAPA's legislative information? If so, how did they address the problem that the AAPA's legal information has gaps (at least as far as I'm aware)? Did they fill these gaps with additional research? Could the authors provide a cite directly to the AAPA's legislative information database? Second, the authors do not provide a thorough discussion of the six elements of the AAPA's Modern PA Practice Act until well after these six elements are introduced for the first time. I believe it would be easier to understand the contributions made by this paper if it included a discussion of the six relevant elements the first time they are introduced in the Methods section.</p> <p>Three</p>
-------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

	<p>Did the authors adjust the wage data for inflation? If so, this does not appear to be stated in the paper. Adjusting the wage data for inflation is important for understanding PA wage growth. I believe clarifying any inflation adjustments would improve the paper.</p> <p>Four As I understand the models and results, the authors examine data from 1997 through 2017. Summary statistics tables include five-year increments, but I understand the regression models to include data from all states and all years. Assuming that I understand the models and data correctly, why do the authors not estimate traditional difference-in-differences (DD) models? These data appear to be perfectly set up for DD models, and DD models could account for many factors that may confound the authors' current analysis. I believe DD models would be a significant improvement over the growth models currently presented.</p> <p>Five Whether the authors stick with their current modeling approach or adopt DD models instead (recommended), the authors should consider abandoning the one-SOP-law-element per model approach. By separately estimating models for each SOP-law element, the analysis cannot isolate the impact of one element from another. Of course, including all six elements in the same model may induce problems of multi-collinearity (since state legislatures may often contemporaneously pass multiple elements at the same time). This may necessitate including only the most important elements.</p> <p>Six The authors may consider "promoting" Supplementary Table 2 to a main table. The paper includes a lengthy discussion of Supplementary Table 2, so it seems warranted to include it as a regular table.</p> <p>Seven The first paragraph of the Discussion section was important and easy to follow. However, the remaining paragraphs of the Discussion section seem disconnected from both the results and the overall purpose of the paper. The authors may consider rewriting it to tighten the connection to the rest of the paper.</p>
--	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

#### VERSION 1 – AUTHOR RESPONSE

##### Reviewer: 1

1. More clearly interpreting the results-- the authors find little evidence that SOP expansion has increased PA wages. From a simple economics perspective, there are supply and demand forces. Demand for PAs has clearly increased. If supply has increased by a similar magnitude, perhaps owing to PAs having broader SOP, we would not expect higher wages for PAs from expanded SOP.

*Response: Thank you for your comment. An additional sentence was added to the first paragraph of discussion which now reads:*

*“Over the 20-year study period PA wages increased 2.2-fold with the change in wage primarily explained by time and not specific state scope of practice laws. It is clear that individual SOP laws are associated with increased wage, particularly early in our study period, but the impact of these SOP elements changed over time. For example, full prescriptive authority was associated with a \$5,227 higher wage in 1997, but with a negative wage growth of \$309 for each subsequent year of the study. This is also seen with SOP at practice level, which was associated with a \$3,134 higher wage in 1997, but a \$253 lower wage growth for each subsequent year of the study. Together, this indicates that in the early period of this study, some SOP elements were associated with increased average wage, however, the impact of this increase diminished over time in all such instances. This suggests that the importance of these SOP elements on increasing wage decreased over time.”*

2. It also isn't clear why there would then be a need for the government to intervene in some fashion to raise PA wages. This was my takeaway from the last sentence of the conclusion-- but perhaps the authors did not mean it this way. Why is a 220% increase in PA salary insufficient compensation?

*Response: Thank you for this comment. The conclusion has been revised and now reads:*

*“Physician Assistant median wage has risen 220% in the past two decades. At the same time, there has been a significant expansion of state scope of practice laws such that the majority of PAs today work in states with permissive regulations. This rise in physician assistant wage is mainly explained by time and the age of providers with minimal explanation by state scope of practice laws. As the PA profession moves towards Optimal Team Practice, future research should examine if this move towards greater autonomy impacts wage, as occurred in nurse practitioners. “*

3. I was surprised to not see a citation to a paper by John Perry:  
<https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7287.2009.00162.x> The paper found a similar conclusion for changes in PA SOP on PA income. I believe that a key factor to consider is independence-- this factor was not discussed in the manuscript. PAs generally have no pathway to independent practice-- unlike NPs. Although there is some movement in this regard in North Dakota <https://www.aapa.org/news-central/2019/04/pas-across-america-celebrate-first-state-with-key-components-of-optimal-team-practice-following-the-legislative-victory-in-north-dakota/> and Utah <https://www.sltrib.com/opinion/commentary/2021/02/24/conor-norris-edward/>

*Response: Thank you for the reference and information. The introduction (P4 Ln 21-35) and discussion (P16 Ln 13-24) have been updated to specifically reference this work, and to compare the study findings to ours.*

4. I think the authors could better frame the results in light of these important differences in SOP changes in PAs vs. NPs.

*Response: Thank you for this comment, the discussion was substantially edited to include discussion of NPs. The discussion now reads:*

*“The findings of this study support previous work by Perry (2009) showing an increase in PA scope of practice did not increase wage.<sup>1</sup> As PAs are able to provide a wider breadth of care there is arguably a benefit to society through an increase in access to care. Yet, previous research indicates that expanded SOP for nurse practitioners (NPs) does also increase wage but specifically related to independence.<sup>1,2</sup> As the majority of states have permissive SOP laws and with this realisation, it is not surprising that the constituents of AAPA have pressed forward to expand practice autonomy further through Optimal Team Practice (OTP).<sup>3,4</sup> The principles of OTP include eliminating a legal requirement for a specific relationship with a physician, creating a separate majority-PA board to regulate PAs, and authorize PAs to directly bill for services.<sup>5</sup> The tenets of OTP will move the PA profession closer to independent practice, similar to nurse practitioners. Future research should then investigate if this expansion of scope of practice impacts PA wage mirroring our nurse practitioner colleagues. “*

5. Another paper by Morris Kleiner et al. finds similar NP wages increases associated with independence. Again-- a key facet missing from PA SOP expansion.  
<https://www.journals.uchicago.edu/doi/abs/10.1086/688093?journalCode=jle>

*Response: Thank you for this reference. It was added and utilized in discussion revisions (P16 Ln 13-24) described above.*

6. I was surprised to not see an estimation that considered all aspects of PA SOP simultaneously. Perhaps none of the SOP changes independently are having an effect, but if PAs can co-sign AND have full prescriptive authority (or some other combination) that will make a difference. At the very least, using the index of SOP presented in Table 1 as a regressor would be an interesting addition. The mean and median SOP index is 2 for the first 3 years and then jumps to 3. I think it is important to perform an estimation (or estimations) that investigate(s) the effect of multiple SOP changes as well.

*Response: Thank you for this suggestion. We have added to Table 3 results of additional growth modes including all SOP elements in a single model. The results section has been updated as well to reflect these additional findings.*

## **Reviewer: 2**

1. The literature discussion seems to focus on studies in the medical and health services research literature. The paper's topic, however, lends itself to investigation by other researchers, particularly economists, and the authors may consider reading and citing some of this work. For example, Perry (2009) [\[https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7287.2009.00162.x\]](https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7287.2009.00162.x) examines the impact of SOP laws on PA income. Stange (2014) [\[https://pubmed.ncbi.nlm.nih.gov/24240144/\]](https://pubmed.ncbi.nlm.nih.gov/24240144/) and McMichael (2018) [\[https://onlinelibrary.wiley.com/doi/abs/10.1111/jels.12198\]](https://onlinelibrary.wiley.com/doi/abs/10.1111/jels.12198) examine SOP laws and provider

supply. Discussing these (and other) relevant papers outside of the medical and health policy literature would improve the paper.

*Response: We thank you for this comment. The Perry and McMichael references, and a discussion of their findings, have been added to our introduction (P4 Ln 21-35) and discussion (P16 Ln 13-24).*

2. I believe the paper could be improved with a more robust discussion of the SOP laws and datasets under consideration. First, did the authors gather information on PA SOP laws themselves from the AAPA's legislative information? If so, how did they address the problem that the AAPA's legal information has gaps (at least as far as I'm aware)? Did they fill these gaps with additional research? Could the authors provide a cite directly to the AAPA's legislative information database?

*Response: We thank you for the comment. The first author was an AAPA-PAEA research fellow, and through this fellowship was provided the entire AAPA Legislative history data. These data were compiled by AAPA and double-checked by hand by legislative staff. Additional wording was added to the methods to clarify the data source. This section now reads:*

*"Scope of Practice (IV): The AAPA established the ideal PA practice act which includes the 6 Key Elements of a Modern PA Practice Act: 1) licensure as a regulatory term, 2) full prescriptive authority, 3) scope of practice determined at the practice level, 4) adaptable collaboration requirements, 5) co-signature requirements determined at the practice level, and 6) number of PAs a physician may collaborate with determined at the practice level.<sup>6</sup> Data compiled by the AAPA legislative staff were obtained from AAPA and included which six key elements were approved in each state by year. From this, the total number of key elements in a given state in a given year was calculated. There were no missing data for the number of key elements."*

3. Second, the authors do not provide a thorough discussion of the six elements of the AAPA's Modern PA Practice Act until well after these six elements are introduced for the first time. I believe it would be easier to understand the contributions made by this paper if it included a discussion of the six relevant elements the first time they are introduced in the Methods section.

*Response: Thank you for this comment. A paragraph was added to introduction which now reads:*

*"In the United States (US) physician assistant scope of practice is determined at the state level and includes six key elements. The AAPA's Modern PA Practice Act includes: licensure as a regulatory term, full prescriptive authority, scope of practice determined at the practice level, adaptable collaboration requirements, co-signature requirements determined at the practice level, and number of PAs a physician may collaborate with determined at the practice level.<sup>6</sup> Prior research has shown that as of 2017 the majority of PAs work in states with permissive SOP regulations, defined as 5-6 of the six key elements.<sup>7</sup>"*

4. Did the authors adjust the wage data for inflation? If so, this does not appear to be stated in the paper. Adjusting the wage data for inflation is important for understanding PA wage growth. I believe clarifying any inflation adjustments would improve the paper.

*Response: We have added the US Consumer Price index percent change as a covariate to all longitudinal models in Table 3. This adjustment did not meaningfully affect findings for the individual policy models.*

5. As I understand the models and results, the authors examine data from 1997 through 2017. Summary statistics tables include five-year increments, but I understand the regression models to include data from all states and all years. Assuming that I understand the models and data correctly, why do the authors not estimate traditional difference-in-differences (DD) models? These data appear to be perfectly set up for DD models, and DD models could account for many factors that may confound the authors' current analysis. I believe DD models would be a significant improvement over the growth models currently presented.

*Response: We thank the reviewers for the comment. We did previously explore the use of DD and similar interrupted time series models. However, specific complicating factors within the dataset precluded their application. Specifically, a number of states did not have intervention changes during our study period (both beginning and ending the study period with or without specific SOP elements), and a number of states also adopted and then subsequently rescinded specific SOP elements. As such, a clear pre and post-intervention interpretation is complicated. Due to these complications, we opted for growth models.*

6. Whether the authors stick with their current modeling approach or adopt DD models instead (recommended), the authors should consider abandoning the one-SOP-law-element per model approach. By separately estimating models for each SOP-law element, the analysis cannot isolate the impact of one element from another. Of course, including all six elements in the same model may induce problems of multi-collinearity (since state legislatures may often contemporaneously pass multiple elements at the same time). This may necessitate including only the most important elements.

*Response: Thank you for this suggestion. We have added to Table 3 results of additional growth models including all SOP elements in a single model. The results section has been updated as well to reflect these additional findings. We believe that the results for individual SOP elements remains important, however, and continue to present them in Table 3.*

7. The authors may consider "promoting" Supplementary Table 2 to a main table. The paper includes a lengthy discussion of Supplementary Table 2, so it seems warranted to include it as a regular table.

*Response: Thank you for this suggestion, this table was added to the main manuscript and other tables were re-numbered.*

8. The first paragraph of the Discussion section was important and easy to follow. However, the remaining paragraphs of the Discussion section seem disconnected from both the results and the overall purpose of the paper. The authors may consider rewriting it to tighten the connection to the rest of the paper.

*Response: Thank you for this comment. Incorporating this comment and comments from reviewer #1, we have substantially edited the discussion (See P16-17).*

#### **VERSION 2 – REVIEW**

<b>REVIEWER</b>	Edward Joseph Timmons Saint Francis University
<b>REVIEW RETURNED</b>	08-Jul-2021

<b>GENERAL COMMENTS</b>	I think that the authors have done a nice job of addressing my concerns. The authors may consider adding some information on OTP earlier in the manuscript in the intro. The authors should also carefully proofread the manuscript-- I spotted a number of errors in my reading of the revision.
-------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

<b>REVIEWER</b>	Benjamin J McMichael The University of Alabama System
<b>REVIEW RETURNED</b>	I believe the authors have responded adequately to all of the comments and questions I provided in the previous round.

#### **VERSION 2 – AUTHOR RESPONSE**

##### **Reviewer: 1**

I think that the authors have done a nice job of addressing my concerns.

1. The authors may consider adding some information on OTP earlier in the manuscript in the intro.

*Response: Thank you for the comment. One sentence was cut from the discussion and placed in the 3<sup>rd</sup> paragraph of the introduction to read as follows:*

*With this success, the AAPA is now working to expand practice autonomy further through Optimal Team Practice (OTP). The principles of OTP include eliminating a legal requirement for a specific relationship with a physician, creating a separate majority-PA board to regulate PAs, and authorize PAs to directly bill for services.<sup>15</sup>*

2. The authors should also carefully proofread the manuscript-- I spotted a number of errors in my reading of the revision.

*Response: Thanks. The manuscript was proofread.*

##### **Reviewer: 2**

I believe the authors have responded adequately to all of the comments and questions I provided in the previous round.

*Response: Thank you.*